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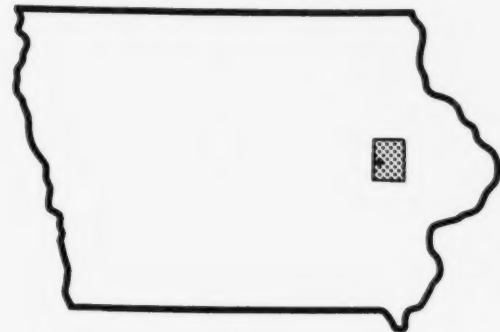
FLOOD INSURANCE STUDY

COMPLETED

22



CITY OF PALO,
IOWA
LINN COUNTY



MAY 17, 1982



Federal Emergency Management Agency

COMMUNITY NUMBER - 190442

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Dry Creek

Panel 01P
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PUBLISHED SEPARATELY:

Flood Insurance Rate Map

FLOOD INSURANCE STUDY

CITY OF PALO, LINN COUNTY, IOWA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Palo, Linn County, Iowa, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert the City of Palo to the regular program of flood insurance by the Federal Emergency Management Agency (FEMA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these Federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.3 (d). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by Kirkham, Michael and Associates and Wallace, Holland, Kastler, Schmitz, and Company for the Federal Emergency Management Agency, under Contract No. H-3998. This study was completed in March 1980.

1.3 Coordination

Community base map selection and the identification of streams requiring detailed study were done in meetings attended by personnel of FEMA; the Study Contractor; and officials of the City of Palo in March 1978. During the course of the work by the Study Contractor flood elevations, flood boundaries, and floodway delineations were reviewed with community officials and with officials of the Iowa Natural Resources Council.

On July 29, 1981, the results of the work by the Study Contractor were reviewed and accepted at a final coordination meeting attended by personnel of the Study Contractor, FEMA, and the City Council of Palo.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Palo, Linn County, Iowa. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, and areas of projected development or proposed construction through 1985.

Approximate methods of analysis were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by FEMA and the City of Palo.

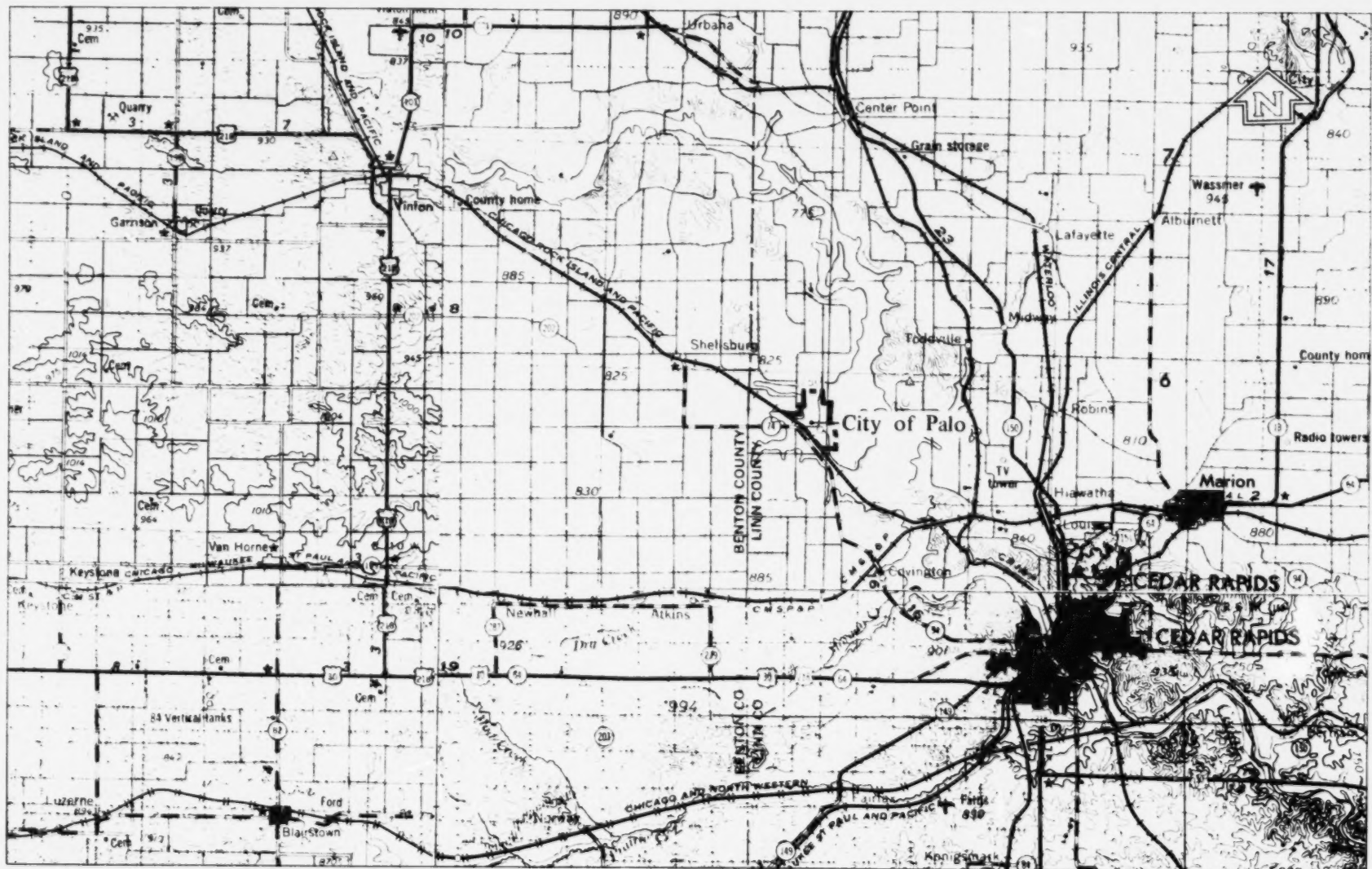
Floods caused by the overflow of the Cedar River and Dry Creek within the incorporated limits of Palo were studied in detail. Two unnamed streams referred to as "Tributary A" and "Tributary B" were selected to be studied by approximate methods; however, the detailed studied streams overlapped these areas so no approximate studies of these two streams were made.

2.2 Community Description

The City of Palo is in west-central Linn County in east-central Iowa and is completely surrounded by Linn County. The City of Palo lies about nine miles north and west of the City of Cedar Rapids. The economy of the area is principally agricultural. The population of Palo was 430 in 1970 (Reference 1).

Most of the precipitation in Palo falls during showers and thunderstorms from April to September. The average annual rainfall is 34.5 inches. Temperatures range from a record low of 36 degrees Fahrenheit (F.) to a record high of 110 degrees F. (Reference 2). The topography of the area is level, with short grasses and trees prevalent in uncultivated areas. The soil in Palo, as listed in the "Soil Survey of Linn County, Iowa" (Reference 2), falls into the loamy alluvial land Sparta-Spillville Association.

A large portion of the community lies in the flood plains of the Cedar River and Dry Creek. The Cedar River is located east of Palo, approximately 0.5 mile, while Dry Creek runs west to east through south-central Palo. Less than half of the Dry Creek flood plain is developed in Palo. The existing development is primarily residential.



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APPROXIMATE SCALE



VICINITY MAP

FIGURE 1

2.3 Principal Flood Problems

Dates of significant past floods on the Cedar River and their estimated flow are March 1961, 73,000 cubic feet per second (cfs); April 1965, 66,800 cfs; June 1857, unknown; and March 1929, 64,000 cfs. These floods caused some damage to residential property, streets and roads. Heavy rainfall in the drainage basin and spring snowmelt caused most of the significant floods. Some highwater marks from these floods have been reviewed, but this information is scarce. Past flooding has not been recorded for Dry Creek.

2.4 Flood Protection Measures

No major flood protection structures are presently in operation on the Cedar River or on Dry Creek.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 per cent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one percent chance of annual occurrence) in any 50-year period is about 40 per cent (four in ten), and for any 90-year period, the risk increases to about 60 per cent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

The frequency-discharge information on the detailed study area for Dry Creek was developed using Iowa Natural Resources Council Bulletin No. 11 (Reference 3). This regional analysis relates drainage area and slope of ungaged streams to frequency-discharge based on records of gaged streams within the state. On the Cedar River, the frequency discharge information

was obtained from Figure 4 of Iowa Natural Resources Council Bulletin No. 11. This figure shows a discharge-frequency curve for the Cedar River. The discharges obtained from Figure 4 compared closely with those obtained from an analysis of gaging station records of a USGS gage located in Cedar Rapids using the log-Pearson Type III discharge-frequency analysis outlined in the Water Resources Council Bulletin No. 17A (Reference 4).

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ MILES)	PEAK DISCHARGE (CFS)			
		10-YEAR	50-YEAR	100-YEAR	500-YEAR
DRY CREEK					
At First Street Bridge	27.1	3,044	5,579	6,865	10,155
CEDAR RIVER					
About 2.4 miles downstream of the confluence of Dry Creek	6,243	53,800	78,500	88,600	113,600

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each flooding source studied in detail.

All existing bridges and culverts were surveyed during the detail study to obtain elevation data and structural geometry. Cross sections were obtained from aerial photography taken in April 1979, at a scale of 1:4800 (Reference 5).

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map.

The range of Manning's "n" values was determined from field inspections, other projects, and local tables (Reference 6). The "n" values used were 0.03 for the channel and 0.07 to 0.15 for overbank flow.

The starting water-surface elevations on the Cedar River were obtained from another Flood Insurance Study being performed downstream on the Cedar River (Reference 7). Starting water-surface elevations for Dry Creek were determined by a normal depth analysis. Water-surface profiles were

developed using a HEC-2 computer step-backwater model (Reference 8). Profiles were determined for the 10-, 50-, 100-, and 500-year floods. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by FEMA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100-year and the 500-year floods have been delineated using the elevations determined at each cross section; between cross sections the boundaries were interpolated using topographic maps developed from aerial photography enlarged to a scale of 1:4800 (Reference 5).

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map. Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to lack of detailed topographical information or to limitations of the map scale, such areas are not shown. In cases where the 100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood

plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of FEMA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced.

The floodway was computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 2).

As shown on the Flood Boundary and Floodway Map, the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

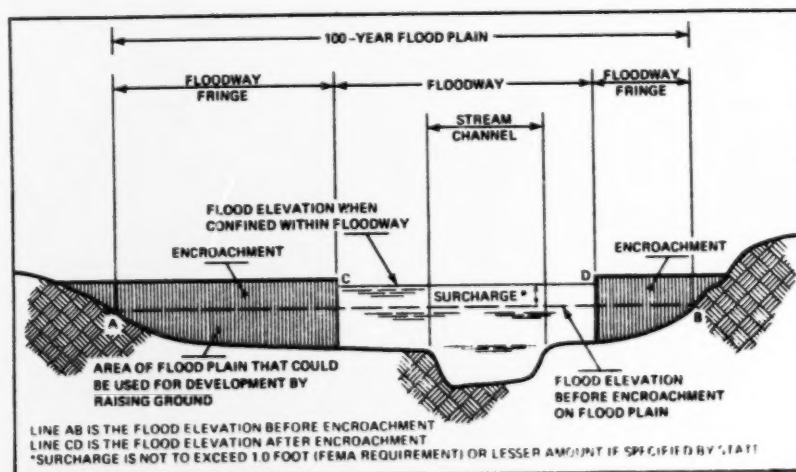


FIGURE 2 - Floodway Schematic

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
DRY CREEK							
A	2615	273	1600	4.3	743.4	742.5	0.9
B	3280	506	3182	2.2	744.3	743.4	0.9
C	4120	150	1115	6.2	745.3	744.5	0.8
D	5270	500	2480	2.8	747.3	747.0	0.3
E	6090	150	1239	5.5	748.1	747.9	0.2

¹ FEET ABOVE MOUTH

TABLE 2

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FLOODWAY DATA

DRY CREEK

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, FEMA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHF), and flood insurance zone designations for each flooding source affecting the City of Palo.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

<u>Average Difference Between 10- and 100-year Floods</u>	<u>Variation</u>
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the City of Palo are shown on the Flood Profiles and are summarized in the Flood Insurance Zone Data Table (Table 3).

5.2 Flood Hazard Factors

The FHF is used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF's are used to set actuarial insurance premium rate tables based on FHF's from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHF's, the entire incorporated area of the City of Palo was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zones A5, A8: Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations are shown, and zones subdivided according to FHF.

Zone B: Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHF's, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Palo is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by FEMA.

6.0 OTHER STUDIES

Hydrologic analysis for the Cedar River which affects Palo was compared with the Flood Plain Information Report prepared by the COE (Reference 9) and the USGS Bulletin No. 27, Cedar River Basin Floods (Reference 10). The results of this study vary from those obtained in the COE study and the USGS study due to the revised hydrology and the more up-to-date topographic data which were obtained. A Flood Insurance Study is in progress for unincorporated areas of Linn County (Reference 7). The Linn County study and the Palo study will agree.

FLOODING SOURCE	PANEL ¹	ELEVATION DIFFERENCE ² BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION ³ (NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
CEDAR RIVER REACH 1	0001	-3.8	-1.0	2.4	040	A8	VARIES-SEE MAP
DRY CREEK REACH 1	0001	-2.3	-0.7	0.5	025	A5	VARIES-SEE MAP

¹FLOOD INSURANCE RATE MAP PANEL²WEIGHTED AVERAGE³ROUNDED TO NEAREST FOOT

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

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FLOOD INSURANCE ZONE DATA

CEDAR RIVER - DRY CREEK

A Flood Hazard Boundary Map has been published for the community (Reference 11). The differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of this Flood Insurance Study.

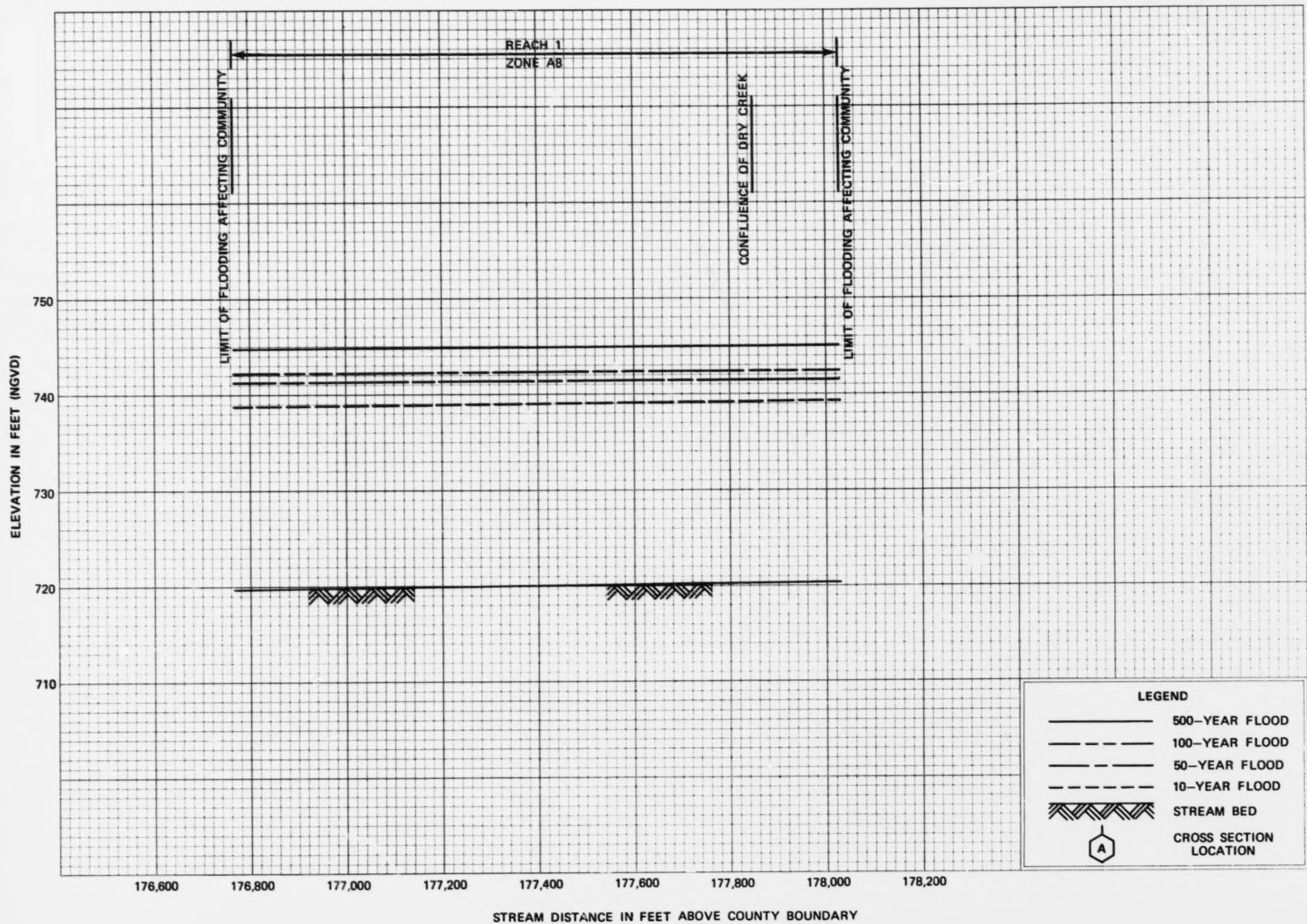
This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, 911 Walnut Street, Kansas City, Missouri 64106.

8.0 REFERENCES AND BIBLIOGRAPHY

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11. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Palo, Iowa, September 1975.



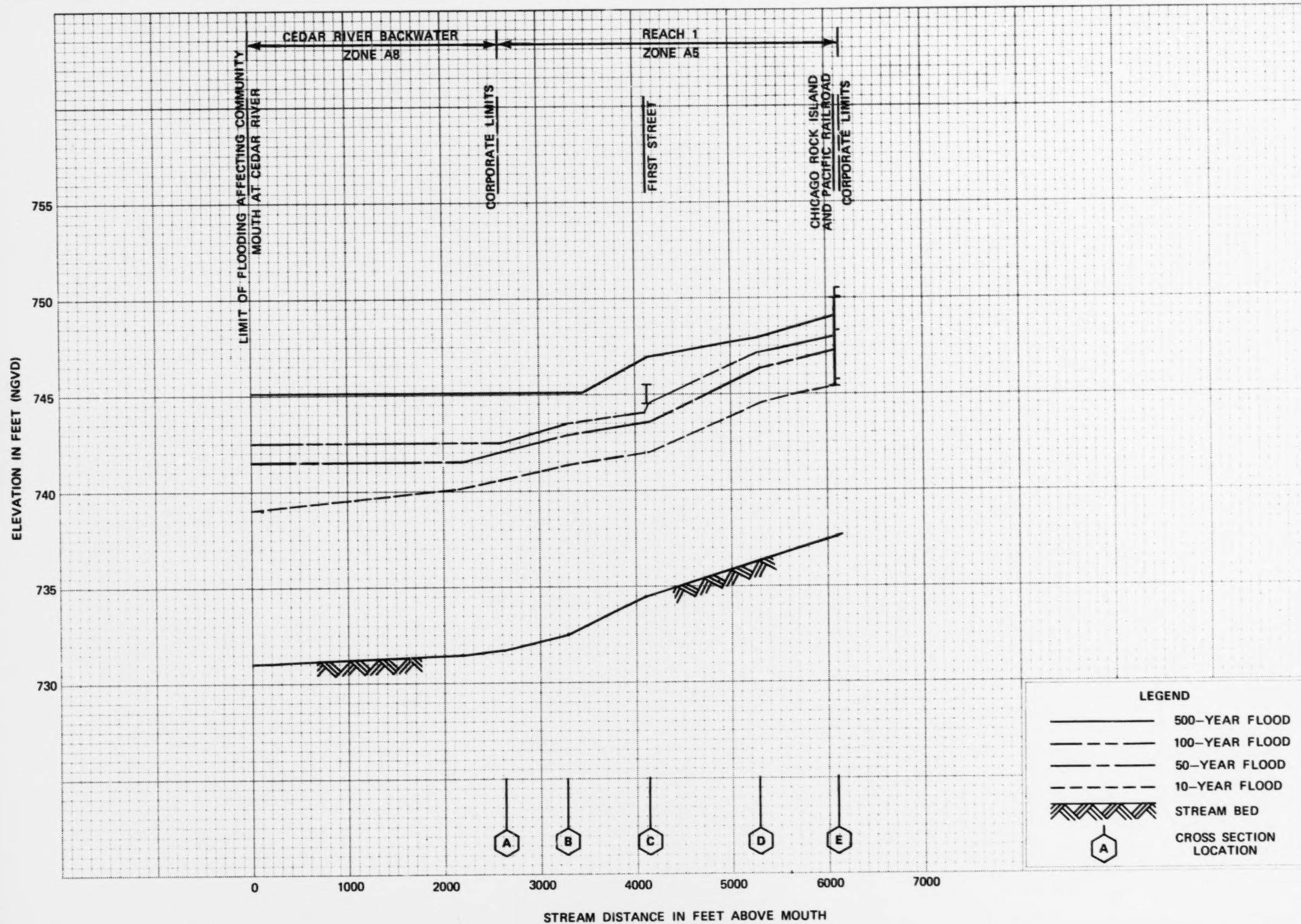
FLOOD PROFILES

CEDAR RIVER

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01P



FLOOD PROFILES

DRY CREEK

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